LOWER SILVER CREEK CONCEPTUAL MONITORING STRATEGY FOR PHASE I FIELD ACTIVITIES

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August 2007

TETRA TECH

This Conceptual Monitoring Strategy (CMS) supports the Phase I field work to be performed by Tetra Tech as a contractor of the Environmental Protection Agency (EPA) in the Lower Silver Creek (LSC) study area. Field work is being conducted to provide further site reconnaissance in support of the Silver Creek Load Reduction Alternatives Assessment; which includes building critical high and low flow metals transport speciation models to evaluate various proposed remediation alternatives. Tetra Tech is performing this work for the EPA under Contract Number 68-C-02-108. The planned reconnaissance field activities will be performed in Phase I during the week of August 13, 2007, while the main sample gathering will be preformed during Phase II scheduled for early October of 2007. This CMS is being prepared for the Phase I filed activities, while a Field Sampling Plan will be developed for the sampling to be preformed during the October 2007 field activities.

Study Area Boundary

The southern boundary of the study area is Highway 248, just north of the Richardson Flat Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) site and the northern boundary of is Interstate 80. The study area boundary includes the entire LSC floodplain and adjacent uplands areas. The study area ranges in width from 2,100 feet wide at the southern boundary near Highway 248 to 3,800 feet wide on the northern end near Pivotal Promontory Road. The approximate area of the study area is 3 square miles.

The majority of the study area is open pasture used for livestock grazing. Some commercial properties exist on the west side of LSC including a cement plant, the Summit County Sheriff's Department, and the Synderville Water Reclamation Facility. The Pivotal Promontory residential community is located on the east side of the study area and is currently experiencing rapid development.

This CMS is to assist field personnel during Phase I activities to gather information about the site for preliminary remedial designs and high/low flow critical conditions metal speciation transport model development. Phase I field activities will assist in obtaining a clearer understanding of the study area and further refine surface water, groundwater, soil and sediment sampling field activities being planned during Phase II. The critical high flow metals transport speciation model will be constructed around the US Geological Survey (USGS) study conducted during April of 2004. However, the existing study area data for the critical low flow period does not provide sufficient detail to construct the metal transport model. Phase I and Phase II activities will gather necessary information to build the low flow critical condition model.

Background

Silver Creek is located in Summit County, Utah with the headwaters located upstream of Park City and flowing into the Weber River, near Wanship. Silver Creek is fed by precipitation (mainly snowmelt), groundwater, springs, and mine tunnel discharges near the headwaters. The CMS addresses the approximate 5 mile reach of LSC from north of Highway 248 to I-80 (Figure 1). The stream flows between Highway 40 to the west and the Union Pacific Rail Trail to the east in this reach. LSC includes the floodplain and riparian habitat that is up to 3,800 feet wide and upland areas adjacent to Silver Creek. The region is currently undergoing significant development.

Silver Creek is classified for beneficial use Class 3A for protection of cold water fish and cold water species (UDEQ - DWQ, 2004). Water rights for domestic water, stock, irrigation, and recreation are held by public and private entities. Portions of the study area are flood irrigated and the stream is impacted by irrigation runoff and groundwater return flows. Several irrigation ditches have been constructed in the basin. USGS stream flow gauging station 10129900 is located within the study area, downstream of the Snyderville Water Reclamation Facility outfall.

Mining in the Park City area began around 1869. The first shipment of ore, 40 tons, was transported out by rail in July 1870 (UDEQ - DERR, 2002). As many as 10 mills operated along the banks of Silver Creek throughout the history of mining in Park City. Tailings from the mining operations were washed downstream and deposited in over-bank deposits in the floodplain throughout the study area. Irrigation diversions may have spread the tailings and/or impacted Silver Creek waters to areas outside the floodplain. The Big Four Mill located near the present Pivotal Promontory access road was the primary mill operating within the study area. The mill was erected to process the zinc-lead-silver tailings accumulated in the LSC flats (Williams, 1916). The Big Four was said to be the third largest mill in Utah in 1916, consisting of a two-month stockpile of 50,000 tons of ore and the capacity to process 1,800 tons of ore tailings per day (UDEQ – DERR, 2002). The mine operated from 1915 to 1918. The Big Four tailings field was reportedly 3.5 miles long by 400 to 1,200 feet wide and two inches to eight feet deep. Today, the tailings exist in mounds, berms, and hummocks. There are two CERCLIS listed sites upstream of the study area, Richardson Flat and Empire Canyon.

The Utah Division of Water Quality (UDWQ) and USGS have monitored the study area for over 13 years. Silver Creek is listed on Utah's 303(d) list as impaired with a high ranking due to elevated concentrations of zinc and cadmium. In 2004, UDWQ published a Total Maximum Daily Load (TMDL) report in which Silver Creek was listed as impaired by zinc and cadmium because both constituents exceeded the 4-day chronic aquatic-life standards (UDEQ – DWQ, 2004). Soils metal concentrations are also a concern. Lead and arsenic are the risk drivers for soil contamination. The UDEQ completed an Innovative Assessment in 2002 on LSC; based on elevated lead and arsenic concentrations, UDEQ recommended LSC for CERCLIS listing.

The Silver Creek watershed is a joint EPA water and waste program site. The initial TMDL assessment included gross (watershed-scale) load allocations and provided a summary of best management practices (BMPs) to reduce loading. Estimates for non-locationally-specific source control measures were nearly 100 million dollars. However, it was not the intent of the TMDL report to provide sufficient level of detail necessary to justify the expense of specific source reduction and remediation efforts. This study will provide additional water quality and soils data, analysis, and modeling to describe the nature and extent of mine waste and metals loading and transport pathways. The goal of the study is to build off of previous watershed level analyses and TMDL work to review, assess, and provide a combination of management options that maximize the efficiency (pollution reduction and cost) of restoration efforts in the watershed.

The Silver Creek project is part of a larger effort by EPA Region 8 to promote cross-program coordination to better focus resources on protection and restoration. To support this effort, EPA Region 8 recently led the development of a cross-programmatic watershed manual, *Integrating Water and Waste Programs to Restore Watersheds.* The goal of the manual is to enhance coordination across EPA waste and water programs to streamline requirements, satisfy multiple objectives, tap into a variety of funding sources, and implement restoration activities more efficiently, showing measurable results. The manual provides guidance on how to integrate assessment and cleanup activities to optimize available tools and resources and help restore contaminated waters efficiently and effectively.

Phase I Project Description by Task

This CMS covers work to be performed during Phase I activities which include the following tasks:

Task 1: Soils

Establish six transects that span the study area (Figures 2A & 2B). Two landforms will be sampled across each transect, the floodplain area and the uplands area. Proposed floodplain sample locations are represented by blue hollow circles and proposed uplands sample locations by pink triangles in Figures 2A and 2B.

Sampling stations will approximately be located every 250 feet across the floodplain portion of each transect and approximately every 500 feet in the uplands areas. At each transect between two and twelve sample stations are in the floodplain area and between one and five sample stations are in the uplands. A geoprobe will be used in the floodplain area to collect subsurface soil samples that will be analyzed by X-ray fluorescence (XRF) and to assess the thickness of tailings material. In areas where tailings are present, XRF samples will be collected from the tailings profile and from the material underlying the tailings, if practicable. The geoprobe investigation will help quantify the volume of tailings in lower Silver Creek. Soil samples will be collected at upland locations from the 0- to 6-inch depth interval if tailings material is not visibly apparent.

Table 1.
Estimated Number of Phase I Soil Locations

	Number of Samples	
Sample Depth	**Floodplain**	**Uplands**
0-6 in (Surficial)	43	21
4-5 ft[1] (Tailings)	24	0
8-10 ft[1] (Native)	24	0
Total	**91**	**21**

[1] Depths assumed for planning purposes

XRF analysis will be performed on surface and subsurface soil samples to quantify soil metal concentrations for arsenic, cadmium, lead, and zinc. XRF analysis will be performed by Jason Andrews of Tetra Tech's Denver Colorado office upon completion of Phase I field activities.

Nutrient analysis (pH, conductivity, texture, cation exchange capacity (CEC), lime, organic matter, nitrogen, nitrate, phosphorus, potassium, calcium, magnesium, sodium, iron, zinc, manganese, copper, boron, sulfate – sulfur, fertilizer), paste pH, acid-base accounting, and organic matter (original weight minus incinerated weight) analyses will be performed on ten surface samples selected from floodplain areas along transects 1, 3 and 5 (Figures 2A and 2B) where tailings material is visibly apparent. These analytical parameters will be analyzed by Colorado Analytical of Brighton, Colorado. The purpose of these analyses is solely to determine if soil amendments would be necessary to reestablish vegetation following remediation activities. As such, these measurements are not considered environmental data, but information necessary in the assessment of cost and feasibility of potential remedial options.

Mineralogical analyses will be performed on two surface soil samples at the University of Colorado's Laboratory for Environmental and Geological Studies (LEGS). Mineralogy may have a profound effect on metals bioavailability. The frequency of occurrence and relative metal mass of each metal-bearing mineral within each sample will be measured and depicted graphically on a frequency bar graph.

Two to three five-gallon bulk soil samples will be collected and used to characterize the physical and engineering properties of the soil in evaluating remediation alternatives. The soil will be classified and the following geotechnical parameters will be measured by Rock Sol of Boulder, Colorado: grain size analysis including the percent passing the #200 sieve, Atterberg limits, and moisture-density relationship.

The surface soil sample collection will be managed and conducted by Brianna Shanklin of Tetra Tech's Longmont Colorado office, with assistance from Sam Wilkes of Tetra Tech's Charleston West Virginia office. Geoprobe activities will be supervised by Mike Egan and field oversight will be conducted by Chris Hayes of Tetra Tech's Salt Lake City Utah office.

Task II: Piezometer Installation for Groundwater
In an effort to better understand the groundwater flow patterns within the study area, a total of 24 piezometers will be installed by the Geoprobe subcontractor. Piezometers will be installed to a max depth of 10 feet and will coincide will all the subsurface soil sample locations. Each piezometer will be constructed of 3/4-inch inside diameter PVC with three or five-foot screen lengths and 0.010-inch slots. The piezometers include a factory installed sand pack around the well screen. Fence posts will be driven into the ground bracketing the piezometers to deter livestock from damaging the piezometers; caps will be place on the posts. Piezometers will be surveyed by a professional surveyor (Alpine Survey) to obtain the elevations required to generate groundwater elevation maps.

Groundwater sampling will be conducted during Phase I and Phase II of the field sampling program by Brianna Shanklin and Sam Wilkes of Tetra Tech. Water levels will be measured in all piezometers with a water level meter. Groundwater samples will be collected from each piezometer using a dedicated bailer. The groundwater analysis will help establish a knowledge base for evaluating contaminant transport and distribution through the groundwater/surface water interface during the metal chemical speciation modeling effort.

Groundwater samples will be analyzed by an EPA Region 8 contract laboratory program (CLP) facility for dissolved metals (aluminum, cadmium, iron, manganese, and zinc) calcium, magnesium, and sulfate. All arrangements and coordination with the CLP Laboratory are being conducted by Mohammed Slam of UDEQ. Groundwater samples will also be analyzed by ACZ Laboratories, Inc for iron speciation between the ferrous and ferric states.

The geoprobe contractors (Clement Drilling and Geophysical, Inc) activities, including piezometer installation, will be supervised by Mike Egan and field oversight will be conducted by Chris Hayes of Tetra Tech's Salt Lake City Utah office.

Task III: Rhodamine Dye Tracer Experiment
As part of the Phase I field activities in LSC, Tetra Tech will conduct a qualitative dye tracer experiment. This study will be useful in defining the predominant flow patterns and locate the main water course of Silver Creek. The rhodamine dye will be dispensed at the most upstream point of Silver Creek within the study area (Highway 248). The dye plume will be followed down stream through the study area, which will identify surface water flow patterns in Silver Creek. Additional dye will be added to the stream as it becomes necessary for reliable visual observations.

The qualitative visual observations obtained during the dye study will be coupled with stream channel measurements (bank full and wetted width) and physical descriptions of flow deviations. Anticipated deviations to flow include braided channels, irrigation diversions, groundwater contribution of base flow, groundwater sinks, and irrigation water re-entering the stream channel. Dispersion, a natural phenomenon in any stream, will also impact dye concentration as the plume propagates downstream. Channel measurements will be measured at surface water diversions, braided channel locations, re-entrance from braided channels, and tributary streams. An effort will be made to locate and revisit the 2004 USGS tracer study to measure stream channel measurements and determine if the locations are suitable to co-locate the low flow critical condition sample locations scheduled during Phase II sampling.

The data collected will also be used when building the surface water models. The results of the stream channel measurements and tracer study will dictate where Tetra Tech locates analytical laboratory surface water and sediment sample locations for the fall (low flow) sampling event scheduled to be performed during Phase II.

This task will be managed and conducted by Brianna Shanklin and Sam Wilkes of Tetra Tech.

Task IV: Wetland Delineations
The study area is known to contain wetlands, with approximately 10 percent of the area previously delineated and mapped by the NRCS National Wetland Inventory (NWI). Due to its proximity to known wetlands and Silver Creek, the majority of the study area is anticipated to be in an area with high wetland potential. The jurisdictional status of NWI and high wetland potential areas is currently unknown.

Because clean-up efforts proposed for the study area would likely impact any wetlands present within its borders, the US Army Corps of Engineers (USACE) will require a comprehensive evaluation, in the form of wetland delineation, for the entire study area (including previously delineated areas). Tetra Tech scientists experienced with the identification of wetland functions as they relate to jurisdictional status will delineate the wetlands. Information collected in the field will include the following: vegetative characteristics, soil type, geographic location, and hydrologic setting. Coordination with the Utah Regulatory Office will determine the final approach to be used for delineations. It is anticipated that the Routine Approach, Level 2 Onsite Inspection as described in the 1987 USACE Wetlands Delineation Manual will be used. Briefly, this method will include the following:

- Determination of site conditions;
- Identification of plant community types;
- Selection of observation points (quadrates);
- Characterization of plant community types and determination of hydrophytic vegetation status;
- Determination of presence of wetland hydrology and hydric soils; and
- Perform wetland boundary delineation and survey with GeoXT submeter GPS units.

If required by the Utah Regulatory Office, Tetra Tech is also capable of using the Draft Interim Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Western Mountains, Valleys and Coast Region. The field evaluations will identify both jurisdictional and isolated wetlands.

This task will be supervised and managed by David Steed of Tetra Tech's Salt Lake City Utah office. The wetland delineation task will be conducted in accordance with all USACE regulations and guidelines, as the USACE is the regulating agency for wetland issues.

Phase II Project Description

The Phase I soil sampling locations will be concentrated along six transects spanning the study area as depicted in Figures 2A and 2B. However, Phase II soil sampling will be dispersed throughout the entire study area to better characterize the metals concentrations within the project area. Surface water and sediment samples will be taken within the stream corridor and from irrigation ditches within the study area during Phase II.

Phase II of this assignment is tentatively scheduled to take place in early October 2007. Phase II will consist of additional XRF sampling to supplement that performed during Phase I. Phase II will also include low flow critical condition surface water and sediment sampling. Surface water and sediment samples will be co-located together to assist in model development. Groundwater sampling of the piezometers will be conducted to support the groundwater portion of the metals transport modeling. The locations of the surface water and sediment sampling proposed during Phase II will attempt to coincide with the 2004 USGS tracer study. The locations will also be dependant on the observations made during the rhodamine dye tracer experiment. The metals transport speciation modeling will be built around the high flow critical condition based on the USGS Principal Locations of Metals Loading from Floodplain Tailings, Lower Silver Creek, Utah, April 2004 document. A second model will be built to represent the low flow critical condition based on the proposed sampling in early October 2007.

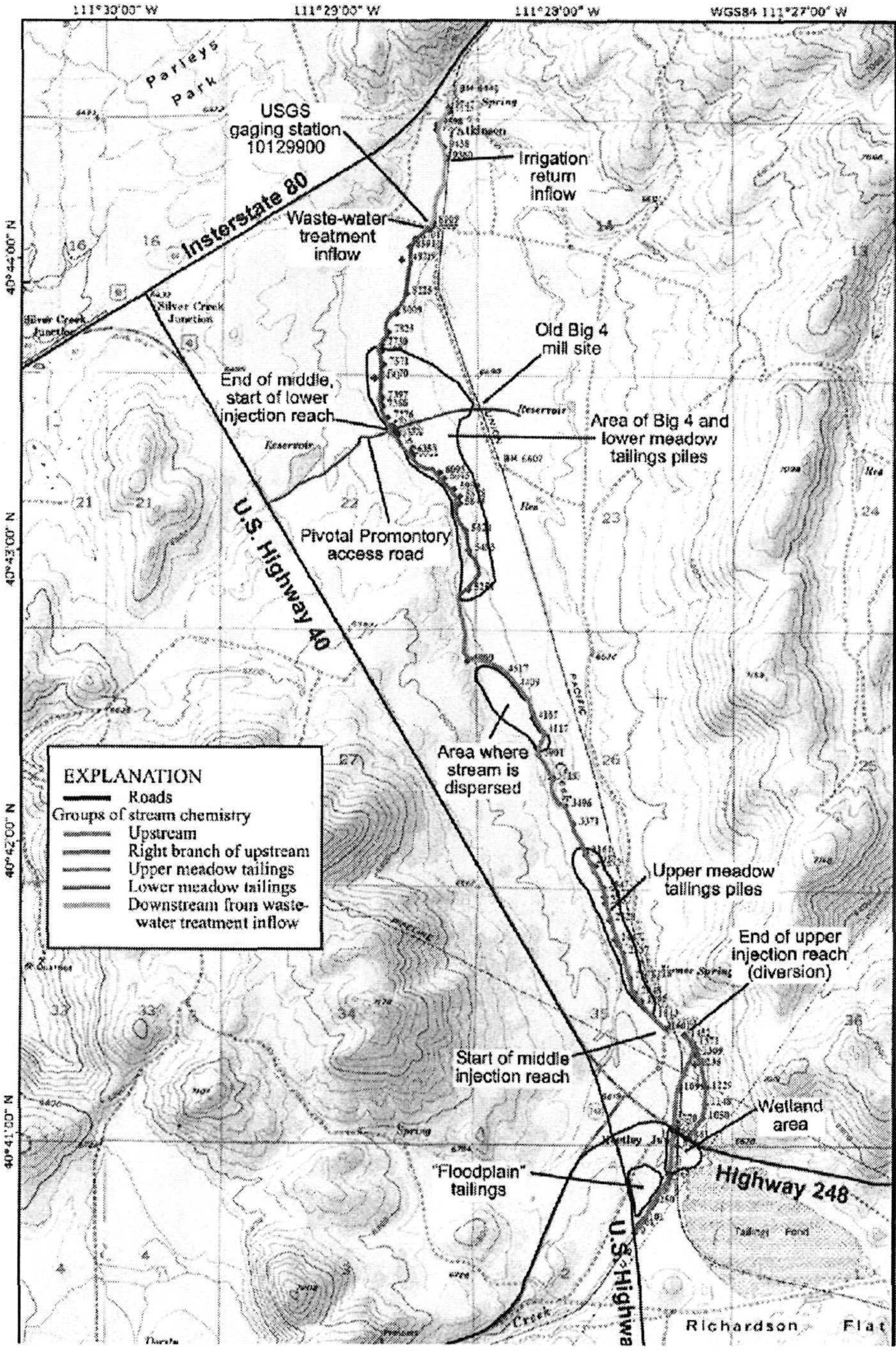
REFERENCES

UDEQ – DERR, 2002, "*Innovative Assessment Analytical Results Report, Lower Silver Creek, Summit County, Utah,*" October.

UDEQ – DWQ, 2004, "*Silver Creek: Total Maximum Daily Load for Dissolved Zinc and Cadmium,*" August.

U.S. Geological Survey, 2004, "*Principal Locations of Metal Loading from Floodplain Tailings, Lower Silver Creek, Utah,*" April.

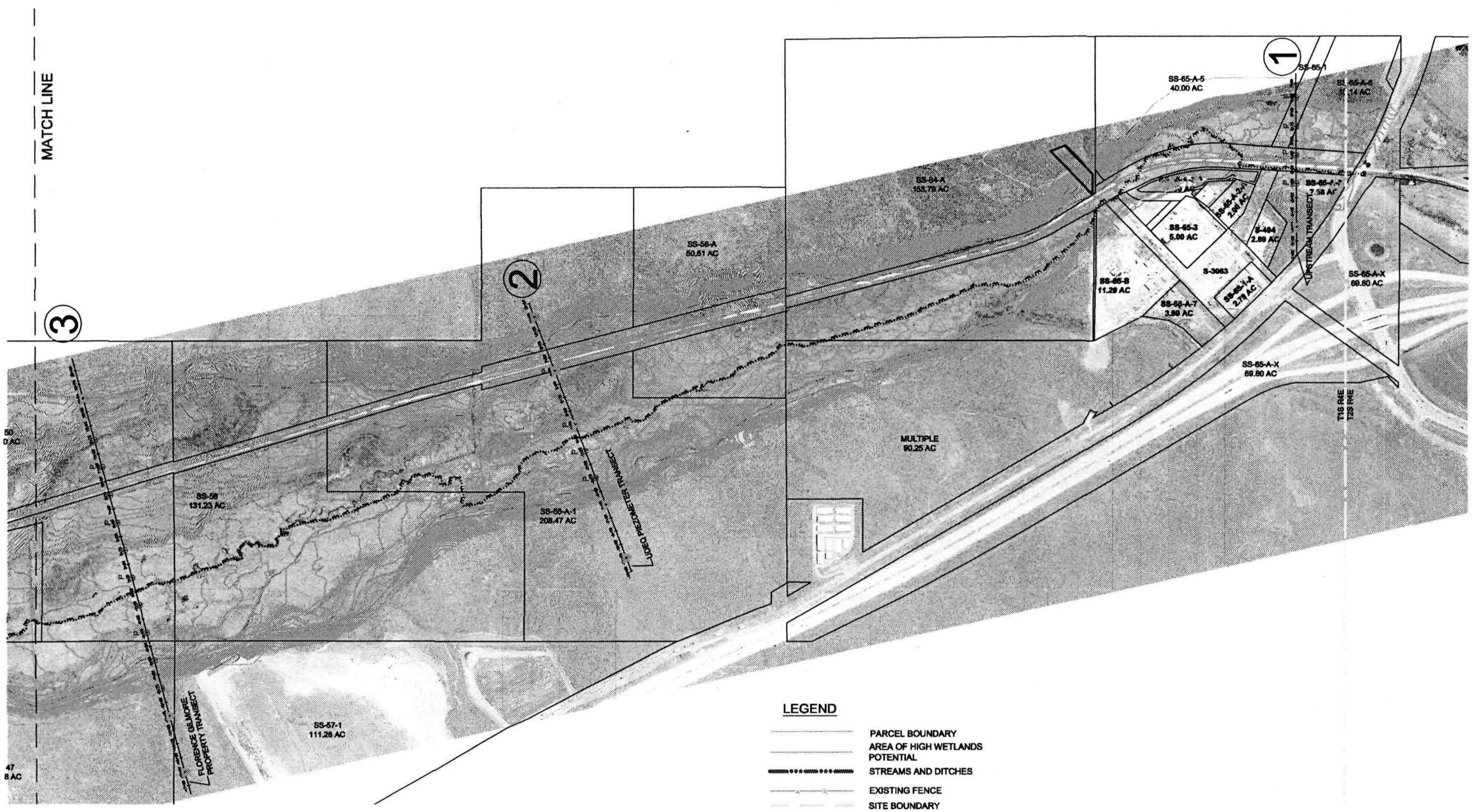
Williams, F. T., 1916, "*Park City Mines for 1915*", Salt Lake Mining Review, January.



SOURCE: (USGS,2004)

SILVER CREEK LOAD REDUCTION ALTERNATIVES		TETRA TECH
LOWER SILVER CREEK SITE LOCATION		FIGURE: 1
DATE: 7/27/2007	BY: BS DRAWN BY: LE	

924_008\TASK 4\SAMPLING\FSP\LOWER SILVER CREEK SITE LOCATION FIGURE.DWG , LAYOUT 1 , 7/30/2007 3:49:11 PM , BRIANNA SHANKLIN



LEGEND

- PARCEL BOUNDARY
- AREA OF HIGH WETLANDS POTENTIAL
- STREAMS AND DITCHES
- EXISTING FENCE
- SITE BOUNDARY
- SECTION LINE
- ○ FLOODPLAIN SAMPLE LOCATION
- △ UPLANDS SAMPLE LOCATION
- P PIEZOMETER LOCATION

N

0 400 800 1200
Scale In Feet

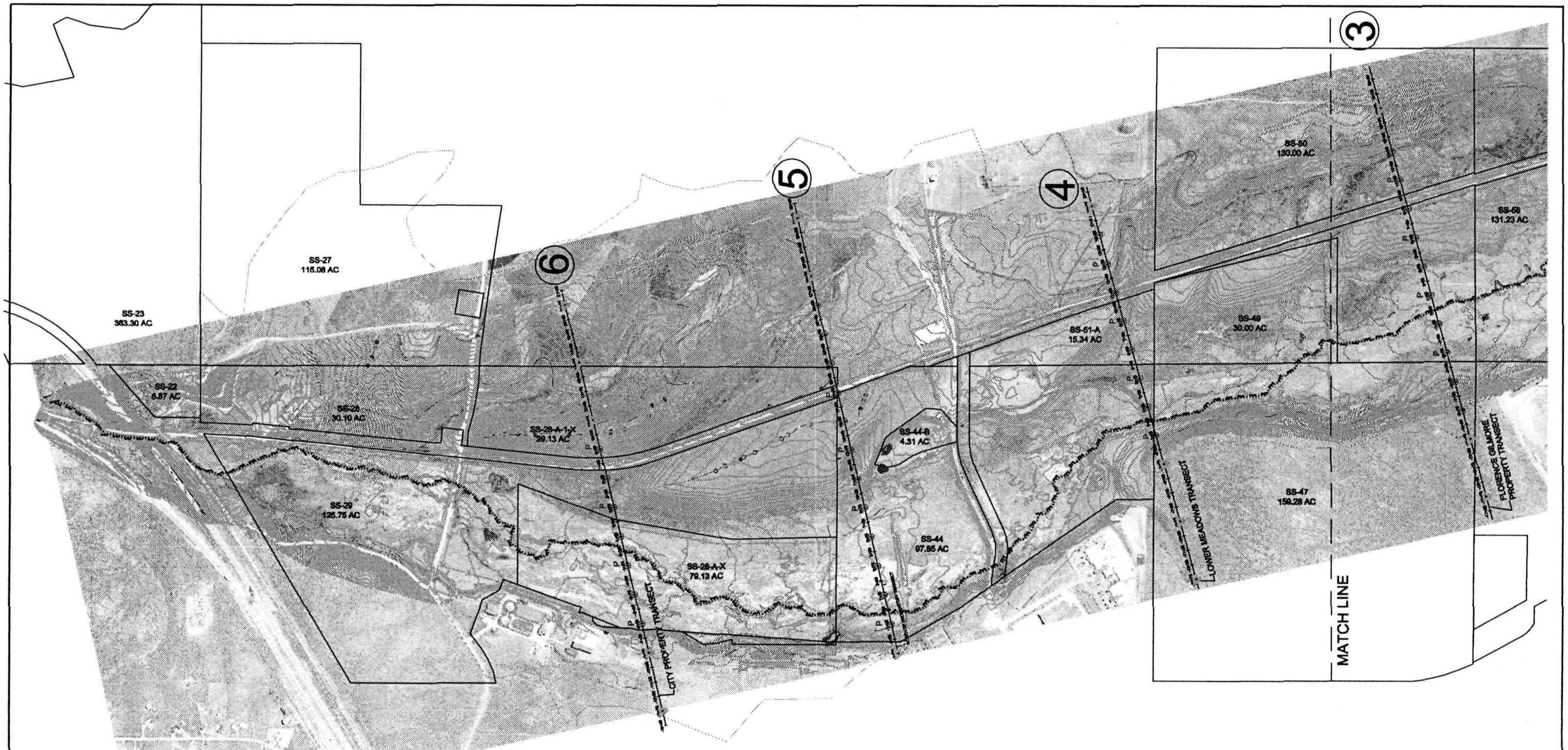
SILVER CREEK LOAD REDUCTION ALTERNATIVES

REVISIONS			
NO.	DESCRIPTION	DATE	BY

FIG. 2A: PHASE I SAMPLE LOCATIONS

TETRA TECH
1900 S. SUNSET ST., SUITE 1-F, LONGMONT, CO 80501
TEL 303.772.5282 FAX 303.772.7039

DESIGNED BY: ##	APPROVED BY: ##	JOB NO.	SHEET:
DRAWN BY: ##	DATE: 7/27/07	19-3924.008.00	2A
CHECKED BY: ##	SCALE: AS NOTED		



LEGEND

PARCEL BOUNDARY

AREA OF HIGH WETLANDS POTENTIAL

STREAMS AND DITCHES

EXISTING FENCE

SITE BOUNDARY

SECTION LINE

○ FLOODPLAIN SAMPLE LOCATION

△ UPLANDS SAMPLE LOCATION

P PIEZOMETER LOCATION

N

0 400 800 1200

Scale In Feet

NO.	REVISIONS DESCRIPTION	DATE	BY

SILVER CREEK LOAD REDUCTION ALTERNATIVES

FIG. 2B: PHASE I SAMPLE LOCATIONS

TETRA TECH
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DRAWN BY: KW	DATE: 7/27/07	19-3924.008.00	2B
CHECKED BY: BS	SCALE: AS NOTED		